Storybook of Workshops

Physical climate system (coordinators: Christoph Raible and Jörg Franke)

El Niño Southern Oscillation is a phenomenon in the tropical Pacific where the atmospheric dynamics is coupled to the ocean. The positive phase of ENSO called El Niño is characterized by reduced trade winds in the equatorial Pacific and a positive SST anomaly in the eastern equatorial Pacific and vice versa for the negative phase of ENSO called La Niña (Fig. 1). This phenomenon is the most important mode of climate variability with worldwide implications, link reduced precipitation over the India and Indonesia for El Niño conditions. Thus, predicting the phases of ENSO is of high socio-economic relevance and has received high attention in the scientific community since the late 1960s.

Given its relevance this phenomenon, in particular the predictability and the methods to generate prediction, will be the focus of the three interlinked workshops of the 'physical climate system' part.

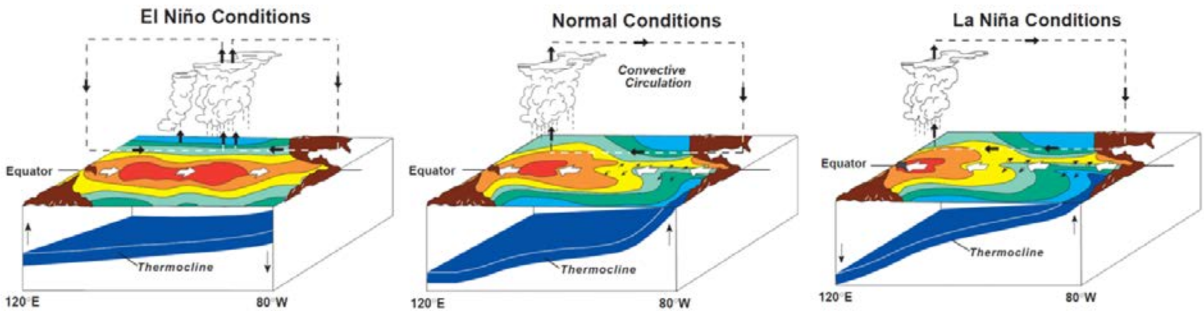

Fig. 1: Sketch of the three phases of ENSO.

1. **WS1: Programing a numerical model to predict ENSO**

In this workshop a numerical model will be programed to forecast ENSO.

Tasks:

- Understand the references below.
- Find necessary data in the internet.
- Program the simple model introduced in McGregor et al. 2012
- Extend the model by the combination mode of the annual cycle and the El Niño/Southern Oscillation (Stuecker et al. 2013)
- Perform predictions.

The students will learn to find data via the internet. Under supervision of the advising person they will explore the relevant literature. Further, the students will learn how to program a dynamical model using the language R.

References:

McGregor, S., A. Timmermann, N. Schneider, M. Stuecker, and M. England, 2012: The effect of the South Pacific Convergence Zone on the termination of El Niño events and the meridional asymmetry of ENSO, Journal of Climate, 25, 5566–5586.

Stuecker MF, Timmermann A, Jin F-F, McGregor S, Ren H-L (2013) A Combination mode of the annual cycle and the El Niño/Southern Oscillation. Nat Geosci 6:540–544.

2. WS2: Programing several statistical of different complexity to predict ENSO

In this workshop statistical models are programed to forecast ENSO.

Tasks:

- Find statistical models predicting ENSO variability for the next months and seasons and the relevant literature
- Find ENSO related data on the web
- Search for indices, sea surface temperature, sub surface ocean data, pressure and surface wind data in the tropical Pacific, etc.
- Program several statistical models to predict the Nino3.4 index
  - Start with simple approaches – the climate model and the persistence model
  - Develop a Markov chain model
  - Develop a multivariate regression model including the data sets identified. Ensure that overfitting is prevented.
  - Develop an analog technique to predict ENSO.
- Combine the models to one forecast. [e.g., Raible et al. 1999].

The students will learn to find data via the internet. Under supervision of the advising person they will explore the relevant literature. Further, the students will learn how to program a statistical model using the language R.

3. WS3: Programing a set of verification measures to verify ENSO forecasts

Basis for the verification workshop are ENSO forecasts done with various approaches described in WS1 and WS2.

Tasks:

- Find several observations data sets online
- Program R-functions for several statistical measures to compare forecasts with observations
  - Bias
  - Correlation
  - root-mean-square error
- Find functions for more sophisticated measure on the web
- Calculation of various verifications measures for multiple combinations of forecasts and observations
- Interpretation of results and decision which models gives the best forecast

The students will learn how and where to find climate data on the internet, program own functions in R, and how to use pre-written function from existing R-packages. Additionally, they will develop a feeling for the specific advantages and disadvantages of a range of verification measures and how to critically interpret them.

Climate Governance (coordinator: Manfred Elsig)

Climate Governance is strongly shaped by law, economics and politics. Three sets of workshops will focus on various aspects of climate governance. The economics part focuses on new ways of carbon-accounting in light of ever increasing global and regional value chains. It allows students to better understand the need for accurate measures to allow to design international treaties. The law workshop focuses on a key case in WTO law and shows how disputes arise if countries have different domestic support policies for climate-related products. It will help students to get a first exposure to how disputes are handled in the inter-governmental organization and how trade and climate concerns are balanced. It also includes a role-play. The political science workshop allows students to explore the students the world of preferential trade agreements (PTAs). They will be asked to carry out certain research activities such as coding climate-related obligations and attempting to explain why there is widespread variation across different treaties.

4. WS4: Carbon-accounting, value chains, and defining climate targets (Economics)

Effective environmental policy requires precise pollution and resource accountancy. This allows for tracking target variables, such as CO2 or methane emissions. In the case of greenhouse gasses, a producer perspective is usually taken. Accordingly, national pollutant and resource use inventories are based on production activities within national territories and environmental policy targets local producers according to the "polluter pays" principle. This principle is also enshrined in the national abatement targets of the Kyoto Protocol (see e.g. Fernández-Amador et al., 2016a,b, 2017). However, recent literature (see Hoekstra and Janssen, 2006 for an overview) argues we should also hold consumers responsible for reducing environmental pressure (see e.g. Ahmad and Wyckoff, 2003, Peters et al., 2012 or Fernández et al., 2016). Such a "consumer pays" view is justified where consumption patterns increase environmental pressure in other geographical regions via geographically fragmented supply chains (aka global value chains, see e.g. Baldwin and López-Gonzáles, 2013). Consumption-based environmental accounting has also become prominent among policy makers. Using input-output (IO) methodology, a literature on construction of production- and consumption-based national pollution inventories for single countries has emerged (see e.g. Fernández-Amador et al., 2016a,b, 2017).

Final production- and final consumption-based inventories account for pollution and resources usage, assigning emissions to the country where the good is where it leaves the factory (final production) or finally consumed (final consumption). In this workshop, students will learn methodologies for quantitative analysis of the situation of national economies in terms of indicators for sustainability footprints. For that purpose, they will be guided through construction and analysis of databases on sustainability footprints defined in terms of carbon dioxide emissions and methane. The extension of these methods to cover other sustainability indicators (water, rainforest resources, etc.) will also be discussed. The students will learn through application, differences between inventories based on territorial or geographic-based production activities, final production activities, and consumption patterns. They will also be led through analysis of how important these differences are when designing international climate treaties that include defined national targets of objectives, and that at the same time may conflict with other existing international treaty frameworks (like the WTO, the EC, etc.).

References:

Baldwin, R., & Lopez-Gonzalez, J. (2015). "Supply-chain Trade: A Portrait of Global Patterns and Several Testable Hypotheses." The World Economy, 38(11), 1682-1721.

Fernández-Amador, O., Francois, J. and P. Tomberger (2016a): Carbon Dioxide emissions and international trade at the turn of the millenium, Ecological Ecoomics. 126. 14-26.

Fernández-Amador, O., Francois, J. and P. Tomberger (2016b): MRIO linkages and Switzerland's CO2 Profile, Journal Aussenwirtschaft. 67-III. 47-67.

Fernández-Amador, O., Francois, J., Oberdabernig, D. and P. Tomberger (2017): Carbon dioxide emissions and economic growth: An assessment based on production and consumption emission inventories, Ecological Economics. 135. 269–279.

5. **WS5: Law and Economics of Climate-related Regulation** (with a WTO case) (Law)

This workshop will focus on a roleplay on the basis of an international trade dispute decided by the WTO Appellate Body: India – Solar Cells (2016) (complaint by the United States against India) regarding requirements imposed by the Government of India on solar power producers to use Indian solar cells and modules. After studying and discussing in small groups the Appellate Body report (i.e. judgment) and other relevant documents, students will play one of three roles in a reenactment of this dispute: the United States, the complainant; India, the respondent; or the Appellate Body, the appeals court.

6. **WS6: Trade Agreements and Climate-related obligations** (Political Science)

This workshop will focus on how climate-related obligations have been negotiated in preferential trade agreements (PTAs). The workshop will start out with an initial session on the role and spread of PTAs in recent years and how they are also used for non-trade or trade-related issues (see figure below). We will also present to students political-economy explanations for the design of climate-related obligations. Students will be asked to screen a selected number of recent PTAs and manually code and map different climate-related features. They will then provide a descriptive account of patterns and provide a qualitative assessment. Finally, they are asked to provide theoretical explanations for the observations and focus in particular on how these obligations diffuse across treaties and where they originate.

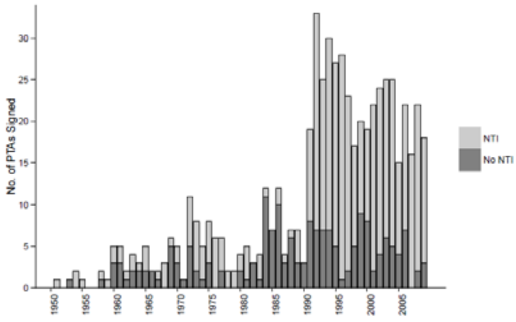

Figure 1. Number of PTAs signed with and without NTIs by year.
Only NTI references in main text are included (not references in preamble).

Source: Milewicz et al. 2015

Climate Economics (coordinator: Ralph Winkler)

International treaties on the provision of global public goods are plagued by the fundamental free-riding problem: each country's contribution will benefit all countries in a non-exclusive and non-rival manner. This prisoner's dilemma aspect and the absence of a supranational authority makes international coordination both crucial and exceptionally difficult to achieve. Countries may either lack the incentive to sign an agreement and benefit from the signatories' contributions or have incentives not to comply with promises made in an agreement. The three climate economic workshops tackle the design of international environmental agreements from an empirical, experimental and theoretical economic perspective.

7. **WS7: State Preference Methods of Environmental Goods** (empirical)

   Cost benefit analysis of climate change impacts crucially require the valuation of environmental goods. However, are not sold directly on the market and hence do not have explicit prices. One way that environmental economists try nevertheless to quantify the value of these is thru stated preference methods, most notably contingent valuation and choice experiment methods. These involve surveys that ask respondents to value hypothetical scenarios involving the environmental good in question. In this workshop, the basics approach, as well as its advantages and disadvantages will be outlined.

8. **WS8: A Public Goods Experiment** (experimental)

   One obstacle for the design of international environmental agreements is that agents react differently to the incentives created by the design than intended by the designers. For example, it is well known that outcomes in experimental game settings consistently deviate from their game theoretical predictions. The most important sources for these deviations are: (i) wrong assumptions about players' preferences or pay-off functions, (ii) players' deviations from rational behavior, both of which cannot be observed independently of each other. In this workshop students will set up their own experimental design for a standard public goods game, execute the experiment and, finally, analyze and evaluate the observed behavior.

9. **WS9: An improved Coalition Formation Game** (theoretical)

   The Coalition Formation Game is the standard economic model of voluntary cooperation in the provision of public goods. However, its predictions about the scope and depth of voluntary cooperation are rather pessimistic. In this workshop students first develop a close acquaintance with the standard coalition formation game. In a second step, students will explore how the rules of the games might be changed in order to increase cooperation. Finally, students will reflect their theoretical findings with respect to real world international climate agreements.